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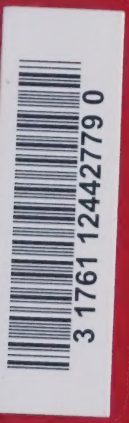

THE SCIENTIFIC OBJECTIVES AND WORK OF THE DEPARTMENT

By G. S. HUME
Director General of Scientific Services

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Survey in conjunction with the R.C.A.F. by using modern shoran methods for measuring distances up to 300 miles or more in length. This work is a great advance over the slower methods and allows basic information to be obtained in areas not readily accessible otherwise. The precision, however, is not quite so high, but is improving with experience in using the new methods.

In former years parties actually made maps of any area on the ground by instrumental surveys. With the advent and perfection of technique in taking air pictures the methods of map making have been completely revolutionized. It is now the custom to have photographs made by flights at selected levels up to 35,000 feet in height, depending upon the scale of the picture desired. Ground control is still necessary and points must be fixed on each picture both for position and elevation, if required, by ground survey parties. With this data the further preparation of the maps is an office job requiring much patience and skill in the use of instruments that have been devised as a means of transferring the information from the picture to a sheet of paper on which the scale of the map is accurately defined.

The Topographical Survey is responsible for the work of ground control for the pictures, the control for each map being tied to the larger control provided by the Geodetic Survey. The obtaining of control data is rather slow and laborious, but recently it has been greatly speeded up and the cost relatively reduced by the use of helicopters in some of the projects. The Topographical Survey also assembles the information from the air pictures, but the actual draughting and final reproduction of the maps is done by the Map Compilation and Reproduction Division with headquarters in the Labelle Building, Ottawa.

As the natural resources belong to each province, the legal surveys for land ownership or land subdivision are done by provincial land surveyors. However, there is much legal survey work in the Northwest Territories and Yukon and in the national parks and Indian reserves. As these are under Federal jurisdiction the legal surveys are done under the direction of the Surveyor General of Canada by surveyors on his staff and by private surveyors holding Dominion Land Surveyor Commissions.

At the beginning of the last war there was much of northern Canada not covered by maps of any kind. A system of photographs taken from aeroplanes consisting of one vertical and two oblique, that is, trimetrogon pictures, were used to produce

maps of 8 miles to the inch or more, particularly for air navigational purposes. Many of these pictures were taken by the United States Air Force, but the maps were compiled by the Legal Surveys and Aeronautical Chart Division and there is now almost complete coverage of all Canada, with more detailed maps from vertical photographs as these become available superseding the maps made from trimetrogon photographs. This Division is responsible also for the coverage of Canada of aeronautical charts according to a world standard set by international agreement.

A more recent development for making contoured maps of a certain scale in conformity with the accuracy required is the use of a radar altimeter, which gives the variations in elevation by recording these in profile on a graph as the plane flies in a straight line over the terrain to be mapped. By flying lines at intervals of 16 miles apart and interpolating between from pictures taken simultaneously it is possible to construct a map of the required accuracy.

The Hydrographic Survey is responsible for the charting of coastal and inland waters, harbours, etc., for Canada. This is a tremendous task and the work must keep pace with the demands for shipping as navigational charts must be kept up to date. For this purpose several ships of varying size are maintained for hydrographic work on the coastal and inland waters.

Information obtained by hydrographic surveys is issued on charts similar to topographic maps of the land areas, but containing all information required for navigational purposes. In addition, tide tables for navigation must be continually revised and issued, gauges maintained for water-level measurements, and current and other phenomena of importance to mariners accurately recorded and issued.

THE GEOLOGICAL SURVEY OF CANADA

The making of maps for civilian use, although these may be devoted to many purposes, is, from the standpoint of the Department of Mines and Technical Surveys, essential for the development of the natural resources, and particularly the mineral resources. Any aid that can be provided to help locate mineral wealth is of paramount importance nationally in the development of the mineral resources. The importance is even greater at present than it was in the past because the requirements for metals have expanded tremendously whereas the rate of discovery of most of the metallic ores has fallen far behind the rate of increase in the use of the metals.

The work of the Geological Survey of Canada, using the base maps provided by the Surveys and Mapping Branch, and compiling on them the geological information derived from field studies that give the clues to the mineral-bearing formations and structures, is thus a prime necessity for the prospector in his search for minerals. The intelligent prospector not only quickly discerns from a geological map what are the best prospecting formations but he quickly appreciates the value of the rock relationships to one another. These latter indicate to him the more promising prospecting regions, and thus his search can be confined to specific areas with better chances of success.

The Geological Survey was founded in 1842, and yet after 110 years of continuous effort only a small fraction of Canada has been systematically mapped geologically. In recent years eighty to ninety Geological Survey parties, using maps prepared by fifty to seventy Topographic Survey parties, have been mapping the more important active and potential mineral areas, and have been making studies of the surficial geological deposits left on the retreat of the great ice-sheets that at one time covered almost every part of the country. In their wake these ice-sheets left soils of varying character and also sand and gravel deposits that are of great importance to the construction industry and in many areas are the sole sources of ground-water supplies. In this work of the Geological Survey the float consisting of hematite from the present Steep Rock iron ore deposits was first noted in 1890, the iron formation of Labrador was first reported in 1893, the gossan of the pitchblende at Port Radium, Great Bear Lake, in 1900, and the Athabaska "tar" sands in Alberta, although reported by early explorers, were first described in 1875. Researches into the possible occurrence of oil and gas in western Canada extend back at least 75 years to the time when the oil fields of southwestern Ontario developed immediately following the strike of the Drake well in Pennsylvania in 1859. From the knowledge gained of the geology of these fields the possibilities of oil fields in Alberta were recognized from the known favourable geological conditions there.

Recent mineral discoveries, therefore, that have added so much to the wealth and stability of the Canadian economy are the result of the accumulation of information from many sources, but in the collecting of which the Geological Survey of Canada has played a conspicuous part. It started its work when Upper and Lower Canada had a population of only slightly more than a million people and has been supplying geological maps,

advice, and information to prospectors and mine operators throughout the years, from the time when mining in Canada was in its infancy to the present when the annual value of mine production approximates $1,200,000,000.

THE MINES BRANCH

The Mines Branch, founded in 1907, has as its main functions, in relation to mining, the establishment of processes for the treatment of ores and fuels and of methods of use for many of the common materials, conveniently grouped under the name of industrial minerals. Many ores are very complex, and before there can be a mine economical methods of ore treatment must be devised. Nearly all ores contain minerals or materials in addition to those whose recovery is the primary purpose of treatment. Thus a treatment devised for one ore may not be wholly satisfactory for another whose primary minerals are identical in composition but whose impurities are dissimilar. Also, a small percentage increase in recovery may be the means of turning what would be considered waste into ore. Waste that becomes ore by the development of a better or cheaper process of treatment may mean many years of life to a community wholly dependent upon a mine for its existence. It must always be recognized that with exhaustion of its ore the mine dies and its community may become a ghost town. Cheap extractive processes are, therefore, of primary concern, and there is a never-ending effort by industry and by Government assistance to keep mines that produce new wealth in operation as long as possible by applying the latest scientific techniques to the treatment of their ores.

In this connection it should be noted that in the last few years a whole new series of radioactive minerals has been brought to light and methods largely new to the mining industry have been devised for the extraction of their uranium content. The Radioactivity Division of the Mines Branch has, therefore, been a recent development separate from the older Mineral Dressing and Process Metallurgy Division, but like it, is concerned with ore treatment, though of quite different types.

An example of the role played by extractive metallurgy in the making of new mines is the process of treatment for the recovery of nickel from the Lynn Lake mine of Sheritt Gordon Mines Limited worked out by Professor Frank Forward of the University of British Columbia, largely in the Mines Branch laboratories in the initial stages, and in collaboration with Mines Branch engineers.

The production of magnesium from dolomite became possible only when a satisfactory process of extraction was found by Dr. Lloyd Pidgeon, now of the University of Toronto, but much of the research work to establish Dominion Magnesium, originally a Crown company, was done in co-operation with Mines Branch metallurgists. Magnesium is the most common metal on the earth's surface and a really cheap method of production would profoundly affect the use of metals for certain purposes for the whole world. A cheap method for the production of magnesium might also be applicable, with perhaps certain modifications, to titanium and certain other metals. Titanium metal can now be produced, though the cost of producing it is much too high to allow its common use even for those purposes for which, more than any other metal, it is eminently suited. However, it will be used for special purposes where such use is justified despite the cost. A new smelting plant is operating at Sorel, Quebec, which produces a high titanium slag from titanium ore mined at Allard Lake in that province.

Thus there is an unlimited field for research on the development of new and cheaper processes for the extraction of metals that could mean much in our national life. In all these processes chemical and spectographic analyses play an important part.

The contribution of the Industrial Minerals Division in the development of new processes for the utilization of such materials as clays, salts, gypsum, limestone, and many other industrial minerals has been outstanding. Canada has the largest supply of asbestos in the world, and co-operation with the asbestos industry has been very close. Clays and shales for use as lightweight aggregates are being tested by being heated in rotary furnaces to produce pellets with glazed surfaces and considerable strength. The ceramic properties of clays have been under constant study and methods for improving the quality of firebrick made in Canada have been developed. Granules of certain types of rocks suitable for making roofing have also been widely tested, and one plant manufacturing these is now in operation in Quebec. Vermiculite, a mica-like mineral that expands on heating, has been under investigation since the autumn of 1950 when the mineral was identified by an officer of the Division in samples from a deposit near Perth, Ontario. Vermiculite when expanded is an insulating material that was previously wholly imported into Canada.

Recently methods have been devised for cleaning impurities from the quartz grains of sandstone, and two plants, one of which is in the Bells Corners area near Ottawa, are under construction to use the processes. Good grade glass sand, hitherto imported, will be available in Canada when these plants enter production. Much work is being done on water needed for industrial purposes and now in short supply in many areas. The problems for investigation in industrial minerals are almost infinite and as most of the materials have a low unit value small industries not able to support extensive scientific investigations have been greatly encouraged and aided by the Industrial Minerals Division.

In the Fuels Division studies are made of the type, quality, and uses of all fuels and of production methods, largely as a means of aiding in devising cheaper and more efficient methods of consumption. The modern tendency to use petroleum and natural gas to displace coal is of great national interest in view of the much larger fuel source in coal and of the communities and people dependent upon coal mining. Experiments are being carried out to utilize coal to better advantage, as in a gas turbine engine, or to transform coal or asphaltic materials to lighter liquid products by the hydrogenation process to aid cheaper transportation to market. Measurements are being made of stress in coal mines as an aid to safer and deeper mining, particularly in the high-pitching seams of the foothills and mountains. The fuel problem in Canada is particularly important because most of the country's fuel resources are in eastern or western Canada with a deficiency in central Canada where most of the fuel is consumed.

In the Mineral Resources Division studies are made to assess potential production, mainly of base metals and strategic minerals. An inventory is kept of each mine and mine prospect indicating the extent of development and the ore reserves so far as these can be appraised. Annual reviews of each of the metals and minerals produced in Canada are issued, a number of which are prepared by officers of other Divisions of the Department.

The Physical Metallurgy Division of the Mines Branch deals mostly with the metallurgy of metals in reference to the defence requirements and to those of industry, but mainly the work of the Division has no direct relationship to the encouragement of new mining enterprises as have the activities of the other divisions. In industry there is a need for alloys for certain purposes where special qualities such as great strength or high heat resistance are essential, and research into new alloys to

meet certain requirements has been under way. Also, there is need for the study and application of steels for various uses as well as need for techniques in welding, particularly under extreme cold weather conditions. In the mining field the Division has been doing work on mine drill bits aimed broadly toward extending the service life of the bits. This division handles the metallurgical problems of the Chalk River Atomic plant.

THE GEOGRAPHICAL BRANCH

This Branch was established in 1947 to provide geographical information, particularly for the Department of External Affairs and the Defence Research Board. Its main task at present, however, is assembling, in conjunction with other government departments, the necessary data for the production of a new Atlas of Canada. This Atlas will depict the natural resources in relation to the population and provide a picture of Canada's development as well as much information of great public value. The last Atlas of Canada was published in 1915 and a new one is badly needed. In addition to the Atlas, geographical information is being assembled and published as opportunity permits.

DOMINION OBSERVATORIES

Although one of the primary functions of the Dominion Observatory at Ottawa is to provide accurate time through specially designed clocks maintained to an accuracy of one one-hundredth of a second by astronomical observations, there is also need for the publication of observations for navigation, longitude determination so essential to map making, and for other surveying purposes. Thus, in part, the work of the Dominion Observatory is quite closely related to that of the Surveys and Mapping Branch. The Observatory maintains a magnetic section and the magnetic declination for each map is thus provided from continuous studies and field observations. It also undertakes gravity measurements. The deviation of the pendulum from the vertical, due to the attraction of a mass such as a mountain or high density rocks in the earth, influences the determination of position for mapping purposes. In addition, gravity stations, where the measurements are taken, are used by commercial gravity survey companies in the search for anomalies that are related to mineral occurrences. At the Dominion Observatory a seismograph for measuring earthquakes

or earth tremors has been maintained for many years for scientific purposes. Recently seismograph stations were established at Resolute Bay in the Arctic and on the grounds of Dalhousie University at Halifax. Observations are also being made in British Columbia, particularly on the west coast. Seismology has been adapted to the search for petroleum and natural gas structures, and during the summer of 1951 about $2,000,000 a month was being spent by oil companies in western Canada on seismic surveys.

The Astrophysical Observatory at Victoria, B.C., is concerned primarily with scientific studies relating to the composition and character of the stars, planets, and interstellar materials and the application of the results to terrestrial physics.

DEPARTMENTAL ADMINISTRATION

The Explosives Act is administered by the Deputy Minister of the Department of Mines and Technical Surveys through the Chief Inspector of Explosives. This Act regulates the manufacture, testing, sale, storage, and importation of explosives. Under it explosives factories and magazines for storage are licensed. Inspections are made to ensure that the regulations are carried out. The Division also undertakes the testing of explosives, the investigation of accidents, and the disposal of explosives that have become unsafe for use.

The Department, with the aid of the Cost Inspection and Audit Branch, Department of Finance, administers the Emergency Gold Mining Assistance Act. This Act was designed primarily to assist the high-cost or marginal gold mines to continue in operation over a difficult period, and also to enable such mines to continue to maintain their dependent communities. The Act came into force by proclamation on June 15, 1948, and the assistance actually paid to gold mines to the end of 1951 amounted to approximately $37,000,000.

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